Analyzing the Impact of the Three Gorges Dam on Local Climate

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RESEARCH OBJECTIVES

The Three Gorges Dam (TGD), on the Yangtze River in China, represents the world's largest man-made reservoir, with a hydroelectric potential of 84.7 billion kilowatt hours and flood reduction in low-lying regions downstream. By 2009, the TGD is expected to fill the projected 39.3 billion m^3 storage capacity. The submerged 663 km length of the Yangtze River will have a 1,040 km^2 wet surface area, representing a significant land-use change in topography and evaporation, which in turn is expected to cause changes in regional weather and climate patterns. Previous studies suggest that the annual average near-surface air temperature in the vicinity of the TDG will increase by 0.3°C. However, the impact on local climate resulting from the change in surface area and weather patterns has not been systematically quantified and is not fully understood.

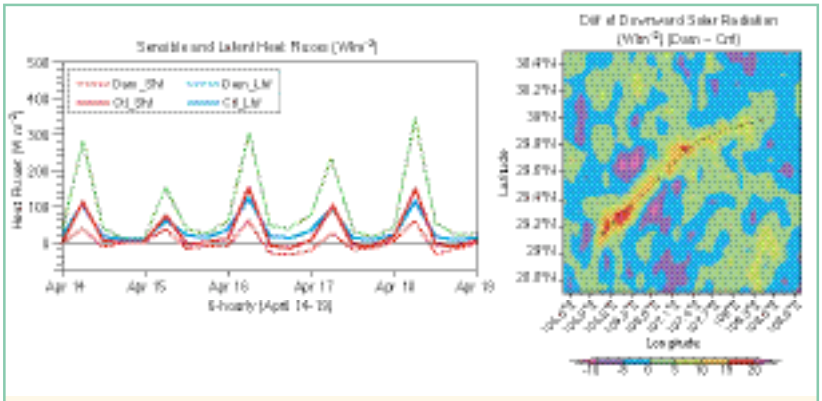

Figure 1. MM5 simulations for April 2–May 16, 1990, indicating (a) a 2 m air temperature, and (b) the difference in downward solar radiation with and without the presence of TGD, which showed a net increase of 10–25 W/m^2 along the Yangtze River Valley area.

The objectives of this sensitivity study are to determine the changes in surface characteristics within the TGD area, from one of steep, vegetated terrain to a large, flat saturated surface, with a potential evaporating rate. We investigate changes in local circulation and moisture patterns and seek to quantify the relative change in temperature, precipitation, and energy fluxes using a regional atmospheric model coupled to a land-surface model.

APPROACH

Simulations were conducted and results analyzed for the period April 2–May 16, 1990, using the nonhydrostatic version of the Penn State/National Center for Atmospheric Research (NCAR) Mesoscale Model Version 5 (MM5) coupled with the Community Land Model Version 2 (CLM2).

ACCOMPLISHMENTS

Initial analyses suggest that increased surface evaporation leads to a colder surface with decreased sensible heat flux (Figure 1a), which further cools the atmospheric column, producing stronger downdrafts of air mass and dissipation of clouds. The reduction in clouds in turn causes an increase in solar radiation (Figure 1b), countering the decrease in surface temperature. However, the increase in descending air mass appears to divert atmospheric moisture out of the region in the lower troposphere, which tends to reduce any precipitation enhancement resulting from the intensified surface evaporation.

SIGNIFICANCE OF FINDINGS

This preliminary examination of the mechanisms associated with local climate change in the TGD region suggests a more comprehensive study, using a fine-scale mesoscale (1 km resolution) simulation for periods up to several years, and a further analysis utilizing remote-sensed observation. The full manuscript to this initial study has been published in *Geophysical Review Letters* (Miller et al., 2005), and a second-phase, more comprehensive analysis is currently being completed by the authors of this study.

REFERENCES

Miller, N.L., J. Jin, and C.-F. Tsang, Local climate sensitivity of the Three Gorges Dam. Geophysical Review Letters 32, L16704, doi:10.1029/2005GRL02821, 2005. Berkeley Lab Report LBNL-58249.

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